Hydrogen and its applications in the steel industry

Hydrogen and its application in the production of steel industry

Hydrogen is a chemical element， ranked first in the periodic table， with the element symbol "H". The element hydrogen has an atomic number of 1 and an atomic weight of 1.008. It is the smallest atom in the universe and the simplest element in nature. Its molecule consists of two hydrogen atoms. It is the lightest gas， with a density of about 1/14th that of air. It has three isotopes， namely (i) protium， (ii) deuterium， and (iii) tritium. Pure hydrogen gas is odorless， colorless， and tasteless.

Hydrogen has the lowest atomic weight of all substances and therefore has a very low density as a gas and as a liquid. The vapor density of hydrogen is 0.08376 kg/m3 at 20 degrees Celsius and 1 atmosphere pressure. Gaseous hydrogen has a specific gravity of 0.0696， making it about 7% as dense as air. At normal boiling point and 1 atm， the density

of liquid hydrogen is 70.8 kg/m3. The specific gravity of liquid hydrogen is 0.0708， therefore， its density is about 7% of that of water.

Hydrogen is a liquid below its boiling point of -253 degrees Celsius and a solid below its melting point of -259 degrees Celsius at atmospheric pressure. It is non-toxic， but can be used as a simple asphyxiant by replacing oxygen in the air. When hydrogen is stored as a high pressure gas at 250 kg/m3 and at atmospheric temperature， it has an expansion ratio of 1:240 with respect to atmospheric pressure.

Hydrogen has smaller molecules than all other gases， and it can diffuse through many materials that are considered airtight or impermeable to other gases. This property makes hydrogen more difficult to control than other gases. Because liquid hydrogen has an extremely low boiling point， leaks of liquid hydrogen can evaporate very quickly. Hydrogen leaks are dangerous because they pose a fire hazard where they mix with air. Hydrogen leaks pose a potential fire hazard.

Hydrogen is chemically stable at room temperature， which is mainly determined by the strong covalent bonds between the hydrogen atoms of which it is composed. The hydrogen molecule is a stable molecule with a high bond energy (104 kcal/mol)， but it reacts with many different kinds of elements， forming compounds with them.

Hydrogen is reducing in nature. It reacts easily with oxygen in most mixing ratios (combustion) and forms water. This also makes it possible to use hydrogen as an energy medium.

Hydrogen has a poor energy density (because of its low density)， although it has the highest energy to weight ratio of any fuel (because it is light). At 1 atmosphere and 15 degrees Celsius， the energy density (low heating value， LHV) of hydrogen is 2400 kcal/m3 and that of liquids is 2030 Mccal/m3.

As a flammable gas， hydrogen will mix with oxygen whenever air is allowed to enter the hydrogen container or hydrogen leaks from any container into the air. The ignition source takes the form of a spark， flame or high heat. The flash point of hydrogen is below -253 degrees Celsius.

Hydrogen is explosive in a wide range of concentrations in air (4% to 75%) and in a wide range of concentrations at standard atmospheric temperature (15% to 59%). Hydrogen can also explode in mixtures of chlorine (from 5% to 95%). The flammability limit increases with increasing temperature. Therefore， even small amounts of hydrogen leaks can burn or explode. Leaking hydrogen gas can concentrate in a closed environment， thus increasing the risk of combustion and explosion. The combustion of hydrogen is described by the equation $H2 + O2 = 2H2O + 136$ kcal.

Hydrogen gas has a relatively high auto-ignition temperature of 585 degrees Celsius. This makes it difficult to ignite a hydrogen/air mixture with heat alone in the absence of other ignition sources. A pure hydrogen-oxygen flame emits ultraviolet light， which is not visible to the naked eye. Therefore， detecting a burning hydrogen leak is dangerous and requires a flame detector. Hydrogen has a very high research octane rating (+130) and therefore does not burst even when burned in very lean conditions.

Although hydrogen is stable， it does form compounds with most elements. When involved in a reaction， hydrogen can have a partial positive charge when reacting with more electronegative elements such as halogens or oxygen， but it can have a partial negative charge when reacting with more electronegative elements such as alkali metals. When hydrogen is combined with fluorine， oxygen， or nitrogen， it can participate in a moderately strong non-covalent (intermolecular) bond called hydrogen bonding， which is essential for the stability of many biomolecules. Compounds that have hydrogen bonds with metals and metalloids are called hydrides. The oxidation of hydrogen removes its electrons， producing hydrogen ions with a single positive charge. Usually， hydrogen ions in aqueous solutions are referred to as hydrogen ions. This species is essential in acid-base chemistry.